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A request for correction by exchanging figures 4A and 4C has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 2.2).

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(54) Method and apparatus for sorting discrete materials and manufactured products.

(57) A sorting method and apparatus is provided in which a flow of particles or objects to be sorted is accelerated by being caused to descend an inclined chute after which the stream or streams discharged from the chute are scanned transversely from one or both sides and while in free fall by one or several linescan cameras. The chute may be arranged to divide the flow into separate side by side streams. In a particular arrangement, two cameras scan the streams successively at respective different levels. The linescan data captured by the cameras is then processed to derive signals for operating down-stream sorting means.

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arrangement and on features required to be recognised.

For recognition of approximate shape or approximate size a single camera 14 viewing transmitted light from a light source 15 is employed, as illustrated in Figures 1A-C. An assumption about the speed of fall must be made.

Where accurate size (length, width, area or perimeter) is required as a sorting parameter, two cameras are employed in a cascade (i.e. one viewing after the other) arrangement (Figures 2A-C). Providing the two cameras are viewing parallel lines a known distance S apart, and the relative timing of the two cameras is also known, the velocity of the object can be calculated. Once the speed of travel is known the length of any object can also be calculated. By virtue of the linescan camera, each object is scanned, in a single line, typically 2000 times per second but this could be faster or slower as required. Illustration of an object (e.g. a tablet) falling past the cascade arrangement of cameras is given in Figure 3. The object's velocity is determined as $V = S/(TA-TB)$ where

TA - is the time when the object just enters into the view of camera A.

TB - is the time when the object just enters into the view of camera B.

S - distance between camera A viewing line and camera B viewing line.

V - velocity of object.

For bichromatic detection of colour a similar arrangement to Figures 2A-C may be employed. In this configuration, a colour filter of one spectral characteristic is employed in front of one camera and a filter of a different spectral characteristic is employed in front of the other camera. Thus only a certain colour will produce a combination of signal strengths at each of the two cameras corresponding to that colour.

For objects, e.g. opaque peanuts or vegetable dices, where viewing from more than one direction is required two cameras can be employed in front and back viewing modes (Figures 4A-C) with two corresponding light sources. For maximum vision all round, up to four cameras may be employed in a configuration illustrated in Figures 5A and 5B, in which the cameras are shown disposed in pairs back and front approximately at the four corners of a notional rectangle lying in the horizontal plane with two of its sides parallel to the plane of the streams of objects being scanned.

Each of the systems described includes apparatus for ejecting from the flow of product those objects that are rejects according to the criteria applied in the scanning operation. The arrangement of the apparatus is illustrated more specifically in Figure 6. Taking the particular case of sorting almonds, the almonds are fed along the vibratory conveyor 11 where an even spread of product is achieved. The rate of feed is controllable. The almonds are guided into the individual channels on the chute 12 where the product is constrained from moving from one channel to another and is aligned longitudinally. The chute 12 allows the almonds to accelerate under gravity thus separating individual nuts from each other. On leaving the lower end of the chute 12, a particular almond first comes into view of the opposed cameras 14.

The viewing area is illuminated by lights 15, preferably producing uniform strips of light. At some distance underneath the lower end of the chute 12 there is an apical separating barrier 16 and the product streaming from the channels of the chute will pass down on the right side of this barrier, as viewed in Figure 6, if allowed to fall undisturbed, on to an accepted product conveyor 20. Between the lower end of the chute 12 and the apex of the barrier 16, and at a level below the site at which the falling almonds are scanned by the cameras, there is a horizontal bank of pneumatic reject nozzles 17, one to each of the individual product streams from the channels of the chute.

The signals produced by both cameras are compared, by an electronic processor 18, against a preset threshold (software program 19) and if the object or part of an object in view is darker than the threshold a signal to energise a pneumatic valve to activate the reject nozzle for the particular channel will be given by the processor. The reject nozzle then blows that object out of the stream of normal product, to fall on the left hand side of the barrier 16 into a reject product receptacle 21.

Further, one camera 14 integrates the total area of the object obtained by repeated scanning and when scaled by time T (inversely proportional to velocity: $V = S/T$) an accurate area is calculated by the processor 18. This area is compared with acceptance limits preset in the program 19 and if it is outside these limits a reject signal will again be issued to the pneumatic valve so that air under pressure is supplied to the respective reject nozzle 17.

Claims

1. A method of sorting a travelling flow of particulate product or discrete objects, wherein the product or flow of objects to be sorted is first accelerated to produce separation and then caused to fall under gravity, preferably in a plurality of separate side by side streams, and data for determining whether individual particles or objects should be accepted or rejected, according to preset criteria, is obtained by at least one linescan camera the direction of scan of which is across the

Fig. 1A.

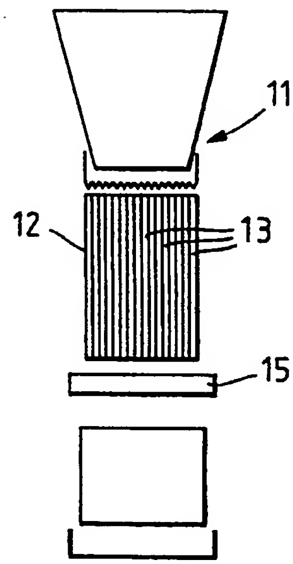

Fig. 1B.

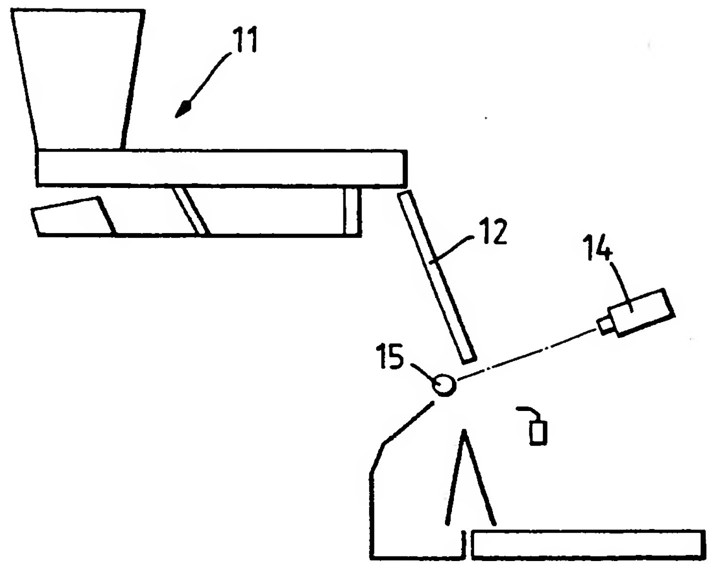

Fig. 1C.

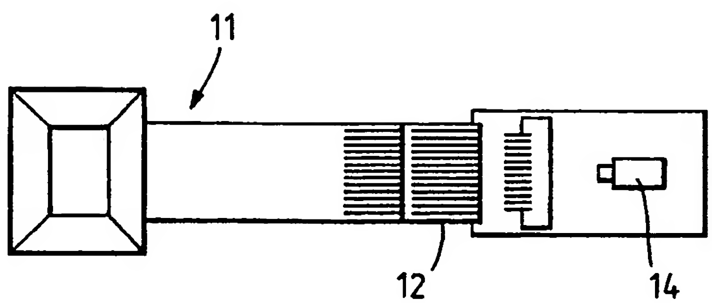

Fig. 3.

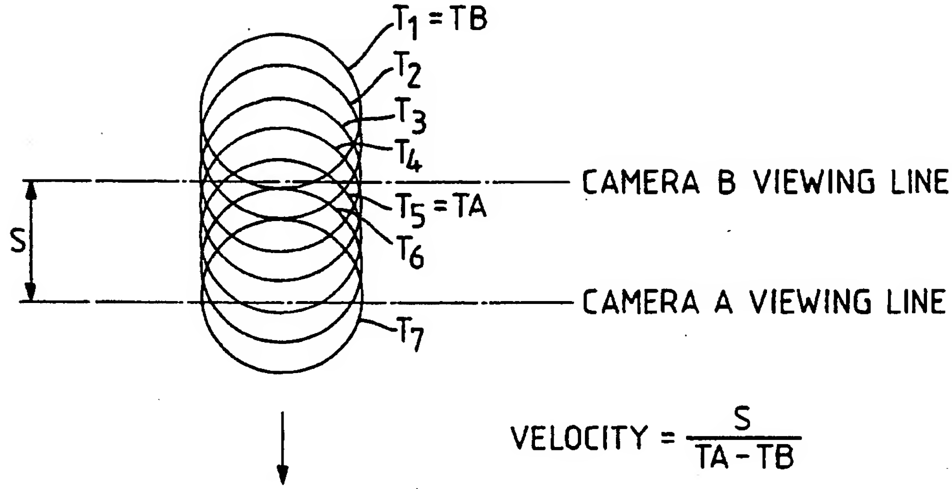
$T_1 = TB$
T_2
T_3
T_4
$T_5 = TA$
T_6
T_7
S
CAMERA B VIEWING LINE
CAMERA A VIEWING LINE
VELOCITY = $\frac{S}{TA - TB}$

Fig. 6.

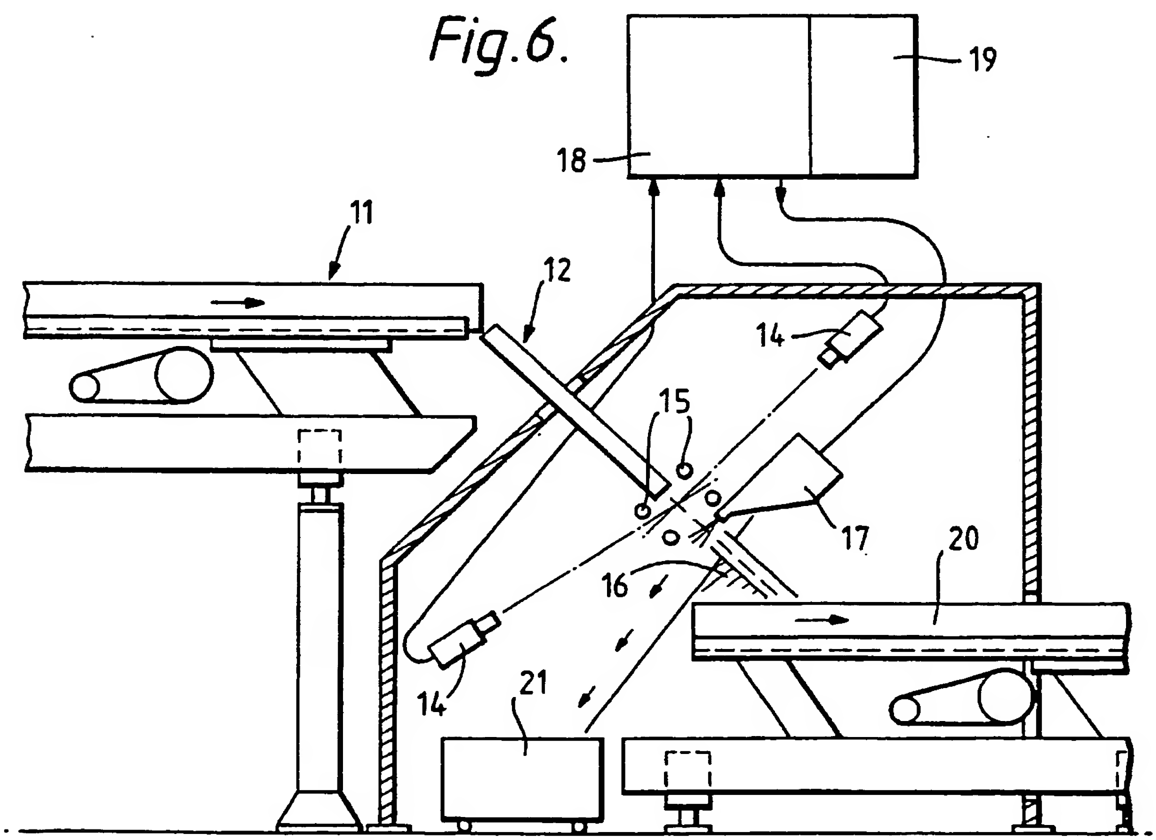
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Fig. 5A.

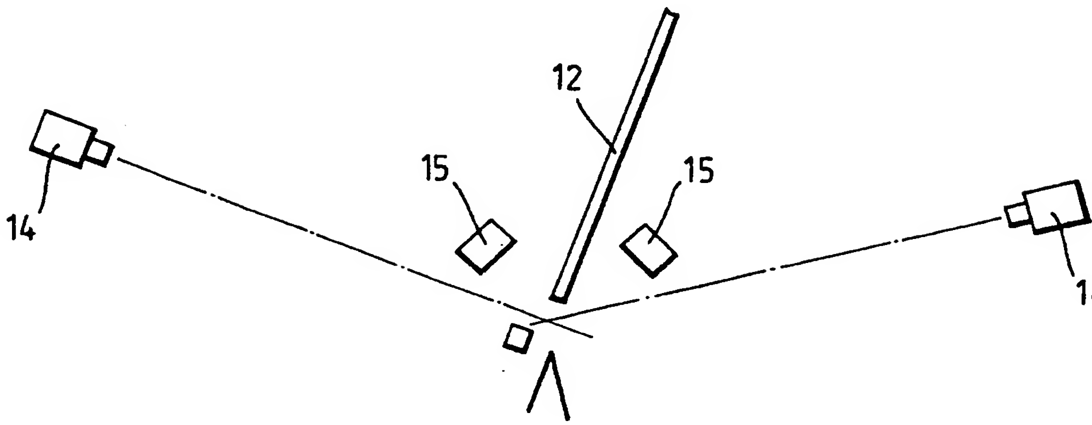

Fig. 5B.